## HEIGHT OF THE ATMOSPHERE DETERMINED FROM THE TIME OF DISAPPEARANCE OF BLUE COLOR OF THE SKY AFTER SUNSET.

By T. J. J. SEE. [Reprinted from Nature, October 1, 1903, p. 526.]

The extreme height of our atmosphere has been determined heretofore from the observation of meteors, which begin to glow when the friction becomes sufficiently intense to vaporize the materials of which they are composed. This method is very satisfactory from most points of view, and will perhaps continue to be used by astronomers. Nevertheless, I think it worth while to direct attention to another method, which is more simple, and which, I believe, will be found equally accurate. It consists in observing with the naked eye the gradual disappearance of the *blue* color of the sky as darkness comes on. It is surprising how accurate a person of good sight can make this observation when the atmosphere is perfectly clear. The time of sunset should be noted, and the time of the last sensible blue of the sky. With the data in the Nautical Almanac a simple computation by spherical trigonometry gives the depression of the sun at the instant the blue fades out into black, and we at once calculate the height of the illuminated particles overhead. The following are the results of some observations taken by the writer at Annapolis, Md.:

| 1903. | Height. | Remarks. |
|---|---|---|
| August 10 | 125 miles | A trace of blue remaining. |
| August 21 | 130 miles | Blue just vanishing. |
| August 22 | 133 miles | Sky just black. |
| August 23 | 135 miles | Blue has disappeared. |
| August 24 | 132 miles | Blue vanishing. |
| | Average 131 miles. | |

The uncertainty of this value will probably be between five and ten miles.

The instant the blue disappears from the sky is a little indefinite, owing to the gradual thinning out of particles in the upper air sufficiently dense to reflect blue light which can be seen by the eye against a black night sky, but I have not found this indefiniteness so great as might be expected. It does not seem to lead to greater uncertainty in the height of the atmosphere than the method depending on meteors. * * *

According to Lord Rayleigh's theory the blue color of the sky is due to reflection of sunlight from minute particles of oxygen and nitrogen in the upper layers of our atmosphere. This theory receives its most striking confirmation from the long duration of the blue color after sunset, showing the great height of the particles which scatter the blue light. There can, I think, be very little doubt that our atmosphere extends to a height of about 130 miles.

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The editor is pleased to be able to add that Professor See promises to communicate to the readers of the REVIEW, in the early future, the observations and the formulae on which the preceding article is based, so that other observers may be induced to make similar observations. From many observations, made in very different portions of the earth, a general result may be obtained that will be of considerable importance to meteorology.—*C. A.*

## PILOT BALLOONS AND THE UPPER WINDS.

By F. O. HILLS. Dated Torrington, Conn., September 22, 1906.

At a church festival held September 21 in this place, a paper balloon was sent up [at about 8 p. m.]. It rose apparently to the height of a mile, going straight up, veering a very little toward the south. When it had reached its highest point, or nearly so, it started to move directly westward, and in a few minutes was out of sight. There was not a cloud in sight, and the sky remained cloudless until 10 p. m. But early next morning (September 22) the wind was blowing strong from the east, and by 8 a. m. it was raining quite hard. Evidently that balloon was in the path of this storm, altho there was no sign of a storm when it was sent up.

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By reference to the morning map of Friday, September 21, it is seen that at that time westerly winds prevailed over Connecticut, as a part of the circulation around a low that was central east of Cape Cod. During the rest of that day, while this low disappeared, another one developed over the Lake region, so that on the morning of Saturday, the 22d, southeast winds prevailed along the coast from New Jersey to Maine. Of course in the interval between these two maps, during the shift of the winds from northwest to southeast, there must have been a period of calm, during which the balloon happened to be sent up. We doubt whether it could have gone as high as one mile, but it is certainly interesting to find that the easterly wind had begun at some high altitude, and that the influence of the low in the Lake region was felt high above us before it was felt at the surface of the ground. Of course observations of the motions of clouds would tell us something of the motions of the upper air; but clouds form principally in ascending air, and a cloudless blue sky is an almost infallible indication of the general presence of descending air. We may, therefore, conclude that, in the present case, a slowly descending easterly wind prevailed high above the calm air of Torrington during the evening of September 21; of course by the time that this air had attained the cloudy area around the low pressure it had become an ascending wind, and was itself cloudy and rainy. Inasmuch as manned balloons and sounding balloons can only rarely be sent up, while the small hot-air and the toy balloons are very common, it would be well for observers to record every case that comes to their attention similar to this observation at Torrington. Of course it is known that, as a general rule, when the sun warms up the lower air in the morning and it ascends, the upper air descends, bringing with it the wind of the upper regions; so that all day long the wind at the earth's surface has a close connection with that prevailing thruout the whole region thru which the vertical exchange takes place; but when the lower winds cease at nighttime, and no vertical exchange takes place, then the upper winds are quite unknown to us, except by the observation of balloons and clouds. In general, whenever calm prevails near the ground it is particularly desirable to know the drift of the upper air, as shown by the balloon.—EDITOR.

## PROFESSOR ADOLF ERMAN.[1]

By WILHELM ERMAN.

[Translated from Berliner National-Zeitung, July 14, 1877.]

Prof. Adolf Erman was called away on the 12th of this

[1] In the Astronomische Nachrichten for 1868, pp. 369-378, there was published a mathematical paper by Prof. Adolf Erman, on the general circulation of the atmosphere, that is but little known to modern meteorologists. Its train of thought is so exactly parallel to that of the papers published by Ferrel in 1858-60 that I have always supposed it to have been suggested by reading either the original memoir of Ferrel or possibly some short abstract. Erman has been most widely known for his work in terrestrial magnetism, but he was first known in early life by reason of his exploration of the meteorological and magnetic phenomena in Russia and Siberia. This mathematical paper of 1868 reveals him, however, as an expert mathematician, applying his knowledge to the most difficult problem of meteorology. In order that we may do justice to the history of the development of meteorology, we take pleasure in preserving the memory of one about whose personal life but little seems to be known by publishing a translation of a biographical note, written by his son Wilhelm, which appeared in the Berlin National Zeitung on the 14th of July, 1877. Dr. Wilhelm Erman is now Director of the Royal and University Library at Breslau. He states that his father lectured on the subject of the earth's atmosphere in his university lectures at Berlin, from the year 1832 onward. Possibly the article in the Astronomische Nachrichten was included among these lectures, and we hope at some time to publish it in full in a second volume of translations bearing on the mechanics of the earth's atmosphere.—*C. A.*

month (July, 1877). His decease will not be without interest to the members of those circles which knew him while yet in his full vigor as student and citizen. Erman sprang from a Swiss-German family, resident successively in Schaffhausen, Mülhausen (Elsass), and Geneva. During the brief period when the family resided in the latter place one branch exchanged its original name of Ermanndinger for the corresponding Gallic form of Erman. Thus it came about that after the Ermans removal to Berlin during the past century the family identified itself with the French colony of this city.

Erman's grandfather, Jean Pierre, was the first of the family to receive an academic education. Until his death at an advanced age, in 1814, he led a life marked by success in many lines of activity, being a popular preacher, the director of the French gymnasium, which he brought to a new degree of success, a member of the academy, and state historiographer to Prussia.

His son Paul Erman (1764–1851) was also originally destined for the pulpit, but in his riper years transferred his attention to the natural sciences, in obedience to his own strong personal inclination. Altho Paul never attended a university, yet he was so successful both as investigator and as teacher at the war college, that upon the occasion of the founding of the University of Berlin, in 1809, he was tendered the regular chair in physics there. Almost up to the day of his death, at the age of 86, he was among the most inspiring of the teachers at the new university. He was elected a member of the academy in 1806, and was its secretary for over thirty years. Paul Erman made for himself a permanent place in the history of his chosen science thru his many valuable contributions to its advancement as well as by his zealous warfare against the errors of the School of Natural Philosophers, altho it was not, as he exprest it, given to him to draw any of the great prizes in physics which fell to the lot of some of his more favored contemporaries.

Adolf, the only son of Paul Erman, was born the 12th of May, 1806; was educated according to the family traditions, attending first the University of Berlin and later Königsberg. The young man received a careful training, especially at the latter university, where he studied under his future father-in-law, Bessel, thus acquiring those powers by means of which he was able to reach out into every branch of natural science during his long, active life, materially aiding in the advancement of each of them.

When scarcely 22 years of age his preparation enabled him to successfully undertake a journey around the world for the purpose of securing reliable data for studying the phenomena of terrestrial magnetism. The careful observations made by him during the three years of this journey form the foundations of the classic theory formulated by Gauss and Weber. With undiminished zeal Erman continued his work along this line during his lifetime, altho busied with numberless other problems as well. His last great work, "Foundations of Gauss' Theory and Phenomena of Terrestrial Magnetism in 1829," undertaken in 1874 at the command of the Imperial Admiralty, and carried out in cooperation with his student, H. Petersen of Kiel, was devoted to this subject. So far as his ill health permitted, similar works occupied all the last years of his life, and their continuation is now wholly in the hands of his faithful colaborer, Petersen.

Space does not permit us here to consider in detail the great activity of his life, especially since he was occupied with problems in nearly every field of science. The many-sided character of his works, too scattered as they are according to modern ideals, is to be explained by the manifold inspirations offered his receptive nature by his trip around the world, and by the many still incomplete publications on the extraordinarily rich collections he made during those years. One should remember also that a portion of that journey lay thru regions in northern Asia which had never before been visited by a scientific explorer, and that his return trip on the Russian corvette *Krotkoi* brought him to Sitka, California, Tahiti, and Rio at a period when even the last-named place lay infinitely farther from the usual routes of travel than it does to-day (1877).

If it be true that this many-sidedness, which enabled him to write works in astronomy, geology, and chemistry worthy of a specialist, also hindered him from producing an epoch-making work in his chosen specialty, yet the same characteristics preserved in him for many years a freshness and a receptivity of spirit which most specialists lose early, and won for him even during his lifetime high and deserved praise from nonprejudiced persons. Thus when, in 1840, Erman received the highest distinction in the gift of the Royal Geographical Society of London, its president, Sir Roderick Murchison, who was certainly a born critic, did not hesitate to acknowledge him to be, next after Humboldt, the greatest living geographical explorer.

There may be a double reason why Erman never received, even in his native country, that recognition which was undoubtedly due to his abilities. In the first place his activity as a teacher in the University of Berlin, where he was privatdocent from 1832, and extraordinary professor from 1834, never reached a large circle of students. This arose from a cause that surely does him no discredit. Erman scorned to present in his lectures the hundred-times repeated wisdom of the text-book, even in a modified form. He frequently exprest the opinion that such knowledge were much better obtained from some good text-book than thru university lectures. His lectures presented the results of his own explorations and original studies, at the same time assuming his hearers to possess already such training and experience as are not usual among students. Naturally the usual attendance at his lectures was very small, yet the few who followed him received thru him rich inspiration, and were sure of his personal help in every way.

The second ground for his nonrecognition is one which should not have any influence under normal political conditions, but which often wielded a decided influence even in the Fatherland during epochs which are, fortunately, now behind us. Contrary to the traditions of his family, Erman had already cast his lot with the Opposition in the early forties. With the growth of his conviction that there was no hope for any *bona fide* concessions to the wishes of the German Constitutionalists, at least on the part of the Government of Friederich Wilhelm IV, he became more and more outspoken in his adherence to a purely democratic and republican form of government. However idealistic may have been the reasons which drove him to this view, yet considering the bitter political strife which has arisen since 1848, one can scarcely blame his victorious opponents if their retaliation pursued the zealous and thoroly unselfish, tho perhaps indiscreet, man into a field that should be entirely divorced from politics.

The glorious success of the Prussian–German policy of the decade 1867–1877, and the but recently revealed aims of the present ruler and his great statesmen have exerted a mollifying influence upon the views of Erman and of many of his cothinkers. When he was in a small circle of trusted friends he did not hesitate to express his delight at the reconstructions effected in late years; but he could with difficulty bring himself to confess the same to his old opponents. Even the slightest suspicion of weakness in character was so distasteful to him that since 1866 he had preferred to withdraw entirely from the public life which up to that time he had followed with so much zest and had even borne some part in. In earlier years especially he never refused his aid wherever there was a serious endeavor to raise the standard of the pub-

lic intelligence, as e. g., thru the courses for workingmen; but here also he insisted upon thoroness and genuineness on the part of the teachers. No one thing was more odious in his eyes than that popularization of science which is based upon mere appearance of scholarship.

The severe illness which first attacked him in 1867 was an important factor in determining the decrease of his activities during recent years. With a slow but not uncertain step it brought about the dissolution of the once tireless mind and body which in earlier years had delighted in activity. Early on the morning of July 12, 1877 a gentle and painless death freed this able man from his sufferings, and bore him from the midst of his large circle of friends, admirers, and relatives.

## EXPLANATION OF THE TABLE OF EXCESSIVE PRECIPITATION.

The REVIEW publishes each month, in Table IV, a statement of the accumulated precipitation during storms of certain intensities. The actual fall during periods of five minutes, ten minutes, etc., is given, in the right hand columns of this table, for each five minute interval up to 50 minutes, inclusive. When the excessive rate is continuous for more than 50 minutes the accumulated precipitation for such longer periods is printed in the following line or lines, and the actual duration of the given amount is found by adding to the figures printed at the top of the column an additional 50 minutes for each additional line employed. The times of beginning and ending given in columns 5 and 6 of this table will show, in such cases, that the total period is a continuous period and that the depths given are the accumulated depths from the beginning of the excessive rate of fall. In the REVIEW for December, 1905, for example, on page 566, the excessive rate at Atlanta on the 2d was continuous from 6:46 p. m. to 9:13 p. m., and the depth of 1.35 inch given in the 5-minute column is not for 5 minutes, but for 55 minutes, and the depth of 2.20 in the 20-minute column of the line below is for the total period of 120 minutes. The case is similar for Jupiter on the same page. The storm of the 2d at New Orleans, La., is recorded on two horizontal lines, but the times are not continuous, and the amounts given on the second line correspond to the times printed at the top of the columns.

The above explanation is prompted by the fact that some confusion has resulted from a too literal interpretation of the explanatory heading of these right-hand columns.—*F. O. S.*

## THE ATMOSPHERE AND THE SOIL.

The Department of Agriculture, thru its various bureaus, seeks to investigate every condition that can in any way affect the growth of the plant and the character, quality, or quantity of the resultant crop. We quote the following paragraphs from an address by Milton Whitney, Chief of the Bureau of Soils, published as Farmers' Bulletin No. 257, on "Soil Fertility". The greater part of the paper is given up to the question of manures and fertilizers, but the following paragraphs relate to atmospheric influences.

*Plants must breathe.*

Of course we all understand that the breathing of the plant is mainly thru its leaves; but the soil also may be a very important factor in the breathing of plants, as it is necessary to have a supply of oxygen around the roots. Physiologists differ as to the office the roots have in regard to the absorption of oxygen. Whether it is a true breathing—the taking of oxygen for the plant economy thru the roots as thru the leaves—has never been decided; but it is unquestionably a fact that roots of cultivated plants require oxygen around them for their healthy growth. We know perfectly well that cultivation of the soil is important or necessary for the best development of many crops, and we say that this is in order to introduce oxygen and make possible the introduction of more water into the soil.

The investigations of the Bureau of Soils seem to indicate that the actual supply of oxygen to the roots may not be the only or even the most important function of cultivation. It seems necessary not only to introduce air into the soil, but, by stirring the soil, to permit the escape of noxious gases that are perhaps given off by the plants themselves, or produced by bacterial action on the remains or excreta of plants. In a crowded room a person begins to feel drowsy, languid, and his head begins to ache. We speak of these sensations, usually, as due to deficient ventilation, too little oxygen, the oxygen having been partly used up, and to an accumulation of carbonic-acid gas; but physiologists now believe that this is not the true explanation, but that the person suffers because there are gaseous emanations from the lungs that are deleterious to human beings. The plant is exceedingly sensitive to gases. On the streets of Washington one of the principal causes of the death of trees is leaks in gas pipes; every year hundreds and perhaps thousands of trees have to be removed, and the usual cause is a leaking gas pipe. The amount of gas is so small that it can not be detected by the odor, but the influence of the gas on the roots is so pronounced that the tree suffers and is likely to die. It seems probable that the ventilation of the soil is necessary not only to allow air to enter, but to allow gases formed in the soil to escape.

Furthermore, air must enter not only for the use of the root itself, but also to oxidize the organic matters given off by the plants—to preserve the proper sanitary conditions in the soil—as I shall explain later. Ventilation to remove noxious gases might increase the yield without affecting the fertility. Ventilation for the purpose of oxidizing organic matter might affect fertility itself.

## THE CLASSIFICATION OF CLIMATES.

We call the attention of our readers to a most instructive series of articles by Prof. R. DeC. Ward, on "The classification of climates", published in the Bulletin of the American Geographical Society, for July and August, 1906. After explaining in detail the many classifications that have been suggested by various students, Professor Ward concludes as follows:

The broad classification of climates into the three general groups of marine, continental, and mountain, with the subordinate divisions of desert, littoral, and monsoon, is convenient for purposes of summarizing the interaction of the climatic elements under the controls of land, water, and altitude. But in any detailed study some scheme of classification is needed in which similar climates in different parts of the world are grouped together, and in which their geographic distribution receives particular consideration. It is obvious from the preceding paragraphs that an almost infinite number of classifications might be proposed; for we may take as the basis of subdivision either the special conditions of one climatic element, as, for example, the same mean annual temperature, or mean annual range of temperature, or the same rainfall, or rainy seasons, or humidity, and so on; or, again, similar conditions of the combination of two or more elements of climate may be made the basis of classification; or we may take a botanical or a zoological basis. Of the classifications which have been proposed, special reference is here made to those of Supan, Köppen, and Hult. That of Supan, taken as a whole, gives a rational, simple, and satisfactory scheme of grouping, whose frequent use in climatic descriptions would tend toward system, simplicity, and facility of comparison. It emphasizes the essentials of each climate, and serves to impress these essentials upon the mind by means of the compact, well-considered verbal summary which is given in the case of each province described. Obviously, no classification of climates which is at all complete can approach the simplicity of the ordinary classification of the zones.

Köppen's admirable scheme of subdividing climates from the botanical point of view is distinctly rather for the use of students of plant geography than of general climatology. The present limits of the different climates in Köppen's map will doubtless need to be changed in several cases, as more detailed botanical studies throw further light on the geographical distribution of different plants, and no rigid delimitation of plant zones is ever satisfactory to everyone. But Köppen's classification has the great merit of recognizing the existing differences of climate between east and west coasts, and between coasts and interiors. The coordination of districts of vegetation and of climate, which this scheme so strikingly emphasizes, is a noteworthy fact in climatology.

Hult's classification is far too detailed, if all the smaller provinces are taken into account; but if only the larger kingdoms are considered, as in Plate II [not reproduced], the scheme is useful. It, however, possesses no advantages over that of Supan, which takes account of more typical characteristics of climate. Ravenstein's hygrothermal types rest upon unsatisfactory data, and regions of very different climatic conditions are grouped together because they happen to have the same mean annual temperature and relative humidity.

## THE WEST INDIAN HURRICANES OF SEPTEMBER, 1906.

By E. B. GARRIOTT, Professor of Meteorology.

Tropical storm development was exceptionally active in American waters during September, 1906. In seeking the causes of